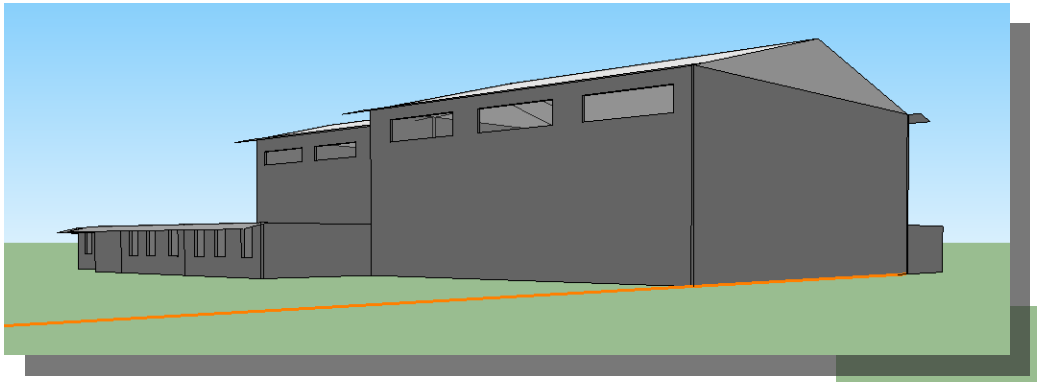
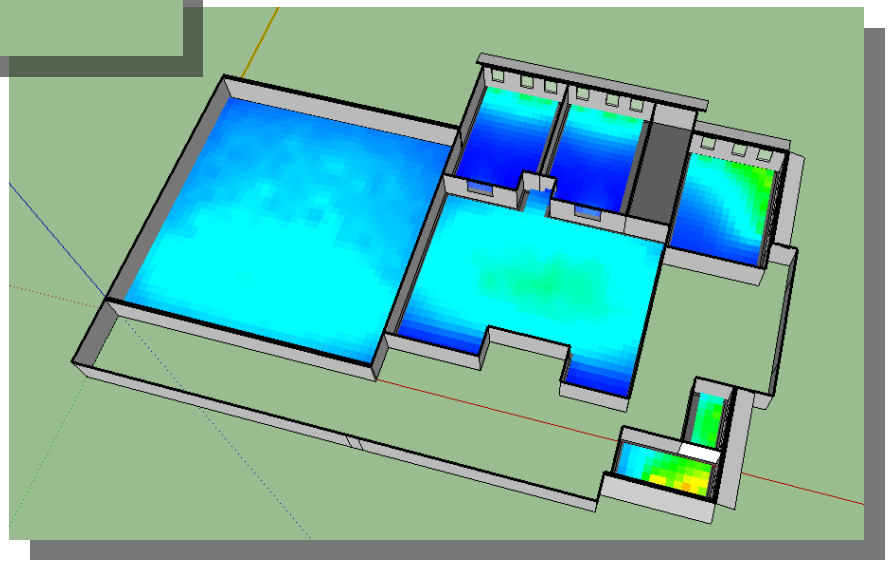
CDC Daylighting Analysis

PNNL
March 07, 2010

Methodology

- Daysim is used to analyze daylighting availability over a year course and glare condition.





Methodology

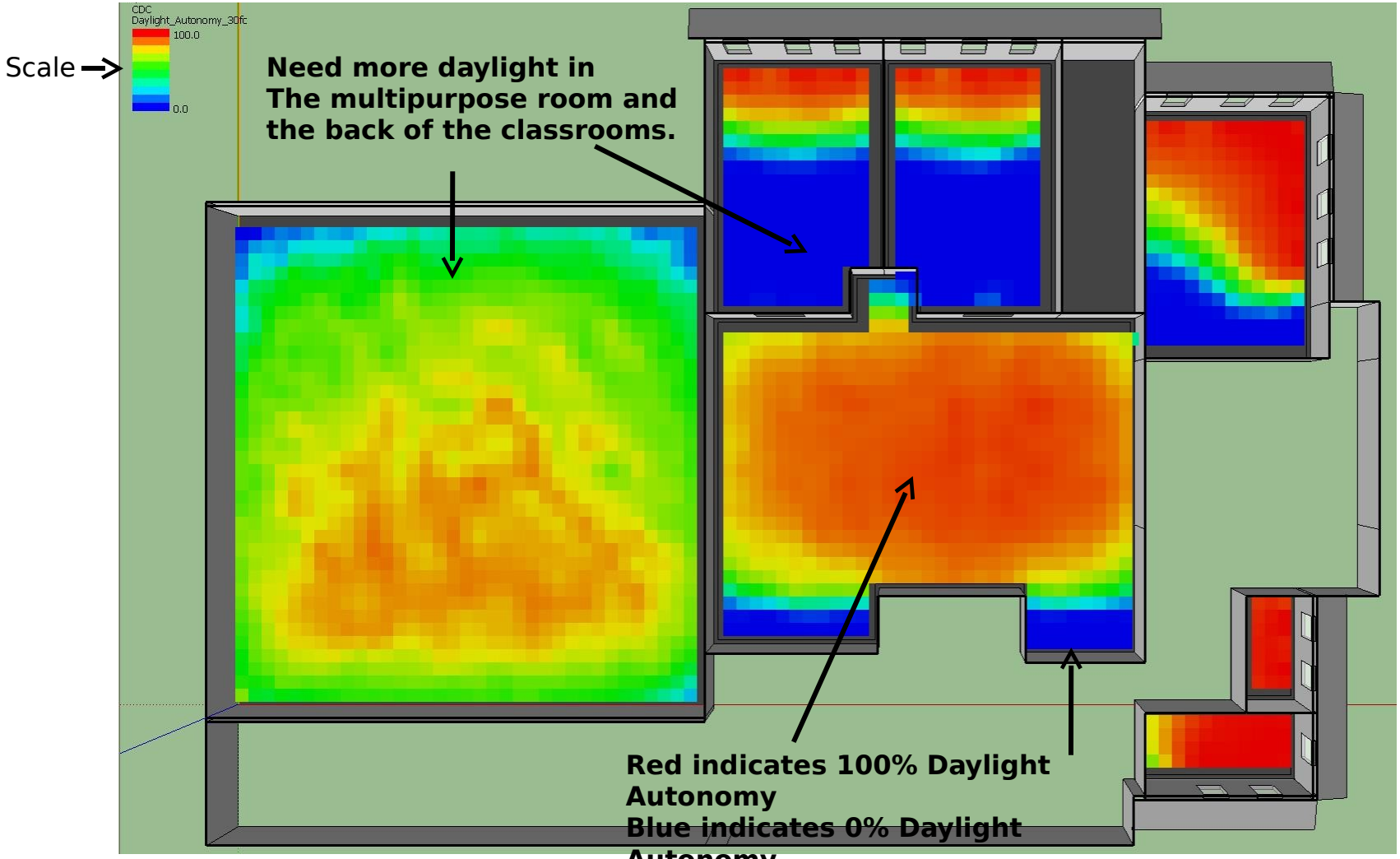
- Daylighting availability is measured in Daylight Autonomy (DA) and Useful Daylighting Illuminace (UDI)
  - DA is the percentage of the occupied times of the year when the minimum illuminance requirement is met by daylight alone.
  - $UDI_{100\text{-}2000}$ is the percentage of the occupied times of the year when illuminance at a point is between 100 and 2000 lux (10 to 200 fc).

- Glare is caused by high illumiance level and high contrast.
  - $UDI_{>2000}$ is the percentage of the occupied times of the year when illuminance at a point is greater than 2000 lux (200 fc).
  - Maximum Daylight Autonomy (DA_{max}) is the percentage of the occupied times of the year when illuminance at a point is more than 10 times the minimum illuminance requirement.

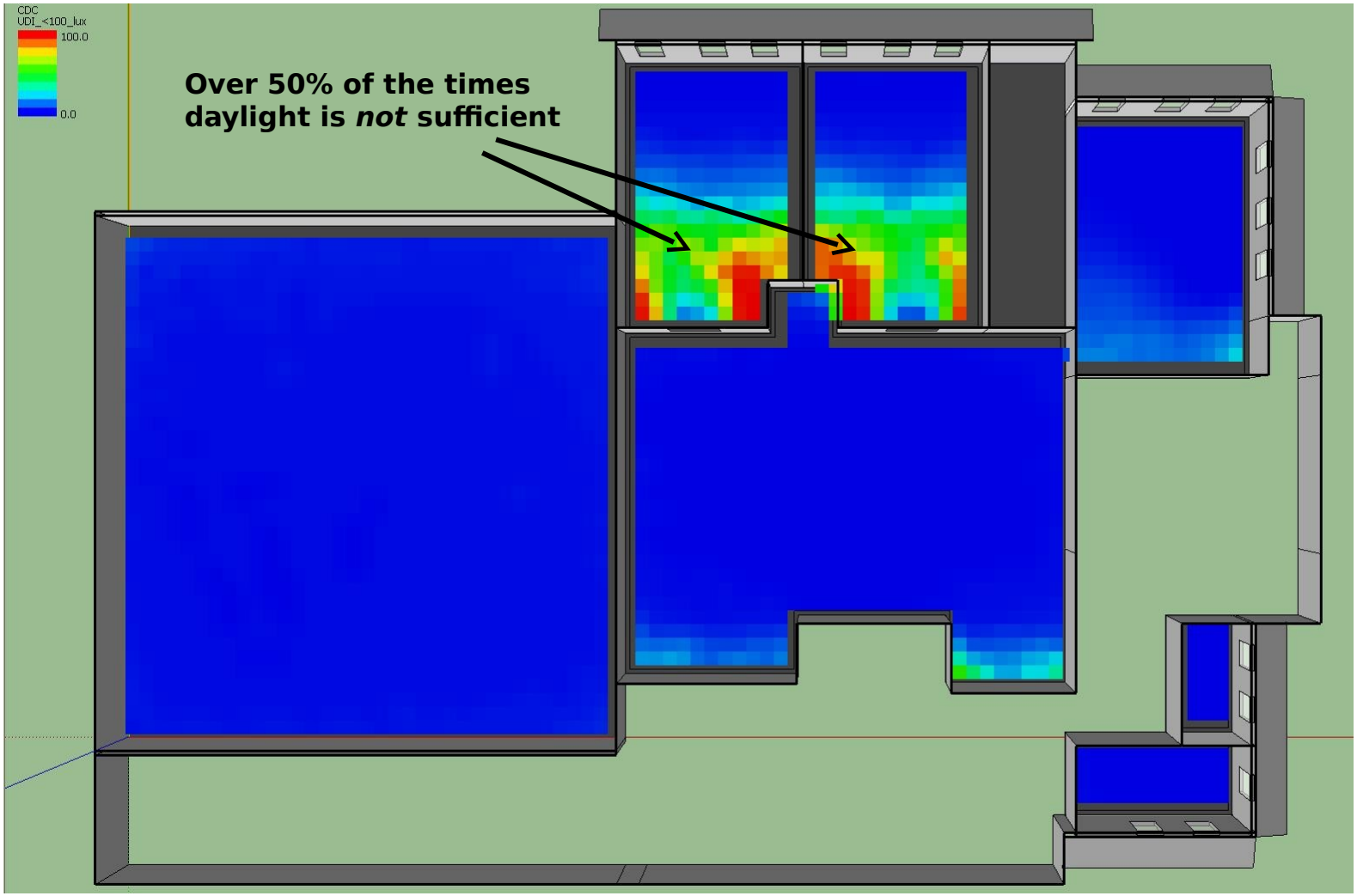
Baseline Analysis

- Daylighting simulation shows that:
  - The 4’ overhand cannot block direct sunlight (from the south) in winter months in the atrium and the multipurpose room.
  - Direct sunlight penetrates in the training room and the director’s office during the whole year.
  - The current window openings do not bring enough daylight into the classrooms.
  - The current window openings do not bring enough daylight into the multipurpose room. (The west-facing windows have been removed.)

Baseline – Daylight Autonomy at 30 fc



Baseline – Areas with less than 10 fc (UDI_{100})



Baseline – Glare Conditions > 300 fc (DA_{max})

Recommendations: Classrooms

- To increase daylight levels in the back of the room, Solatubes (skylights) can be used. (Increasing the size of north facing windows is not sufficient to increase daylight penetration.)
- One sky opening positioned 8’ from the back was simulated in our model. We recommend installing 2-3 solatubes for each classroom, depending the size and the photometric profile of the chosen product.

Recommendations: East-facing windows

- Since it is difficult to shade the direct sunlight into the east-facing rooms (one of the classrooms, director’s office, and training room), we recommend using tinted windows to control the glare condition in the morning.
- Our simulation shows that tinted glass with 40% visible light transmittance can decrease glare and let enough daylight enter the rooms.

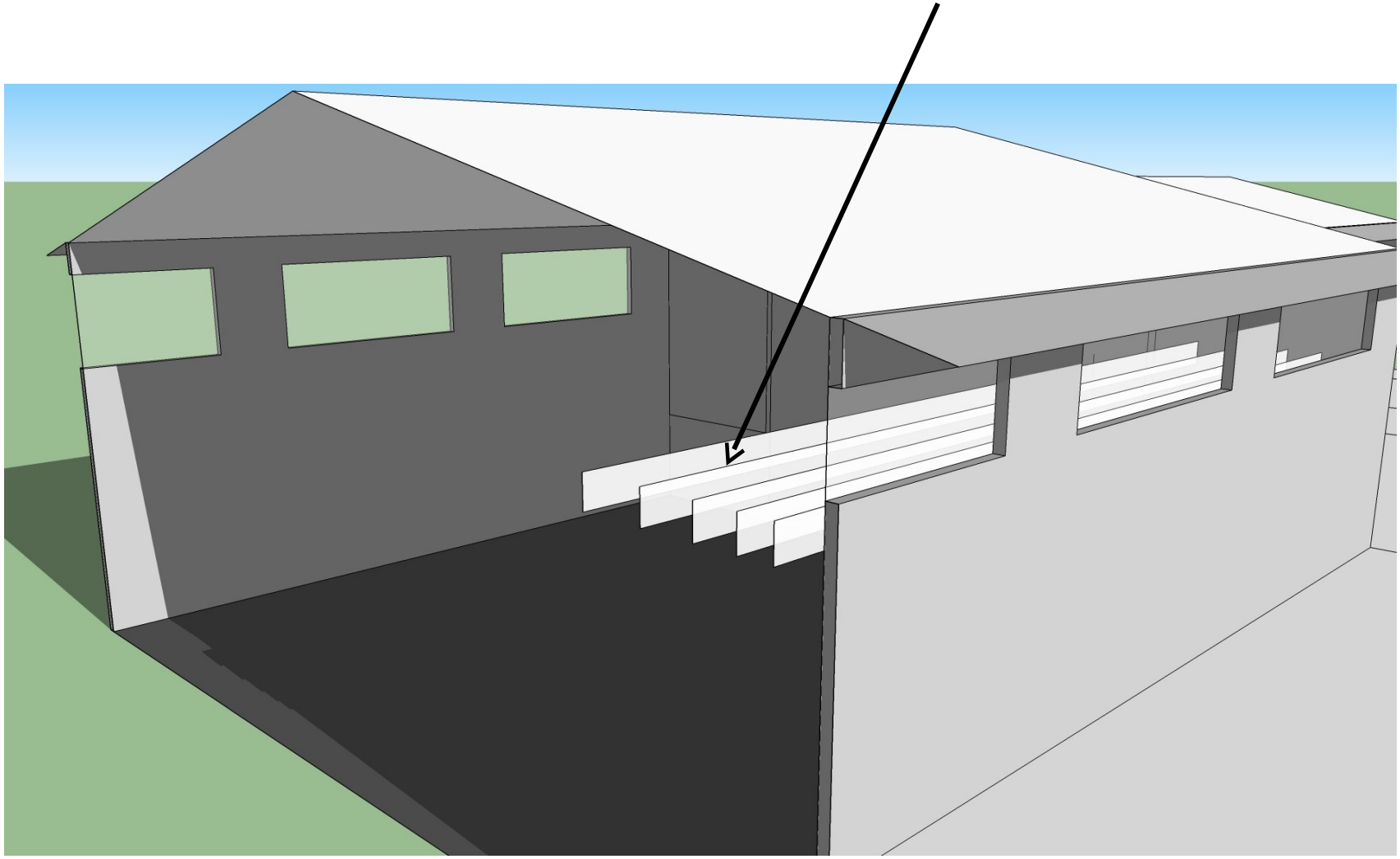
Recommendations: Training room

- The training room has two south-facing windows and one east-facing window. Our analysis shows that the overhand does not block the direct sunlight in the winter mornings. Due to the ceiling height , light shelf is not a good solution.
- Considering that projectors might be be used for training purpose, Roller blinds going bottom up are recommended for darken the space. We also recommend using tinted glass on both south and east sides, so that the windows will look the same from inside.

Recommendations: Multipurpose Room

- To increase the daylighting uniformity, we recommend increasing the north-facing window height from 3’-5” to 6’ tall. The south-facing windows should keep the original size.
- One of the following two measures need to be taken to block direct sunlight from entering the space through the south windows.
  - Install In-the-window lightshelves .
  - Hang translucent fabric baffles on south. Baffles can block direct light and spread diffuse light into the space.

Multipurpose Room – South Baffles

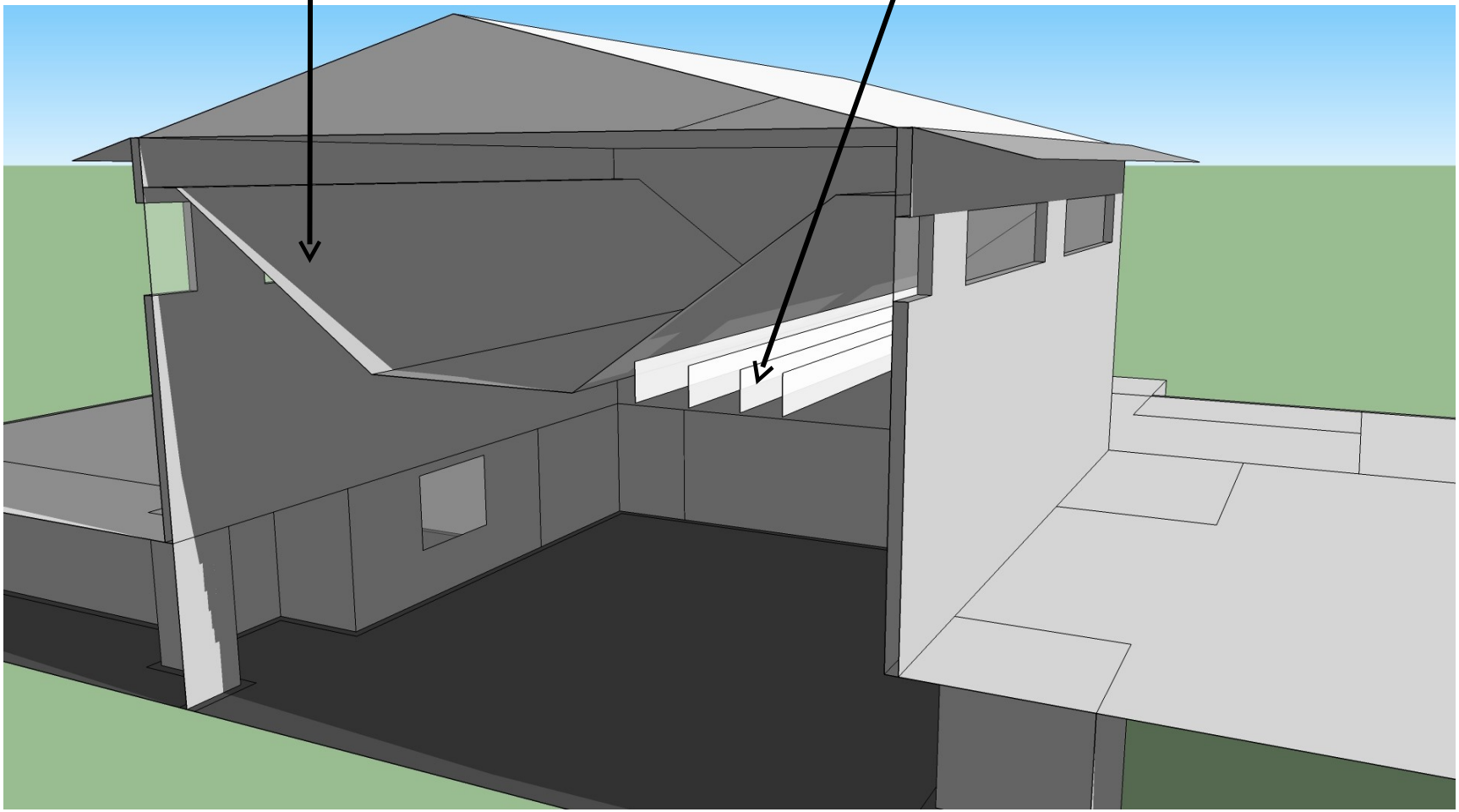


Recommendations: Atrium

- We recommend hanging fabric baffles to block direct light entering the atrium from the south windows.
- Our simulation shows that the ceiling structure that James proposed during the design meeting does not effectively block the direct sunlight. Additional baffles are needed to control glare.
- The baffles (size and height) need to be designed after ceiling structure is finalized.
- We also recommend increasing north windows from 2’-8” to 4’ tall to increase the daylight uniformity.
- An alternative solution is the in-the-window lightshelves.

This ceiling structure does not effectively block direct sunlight.

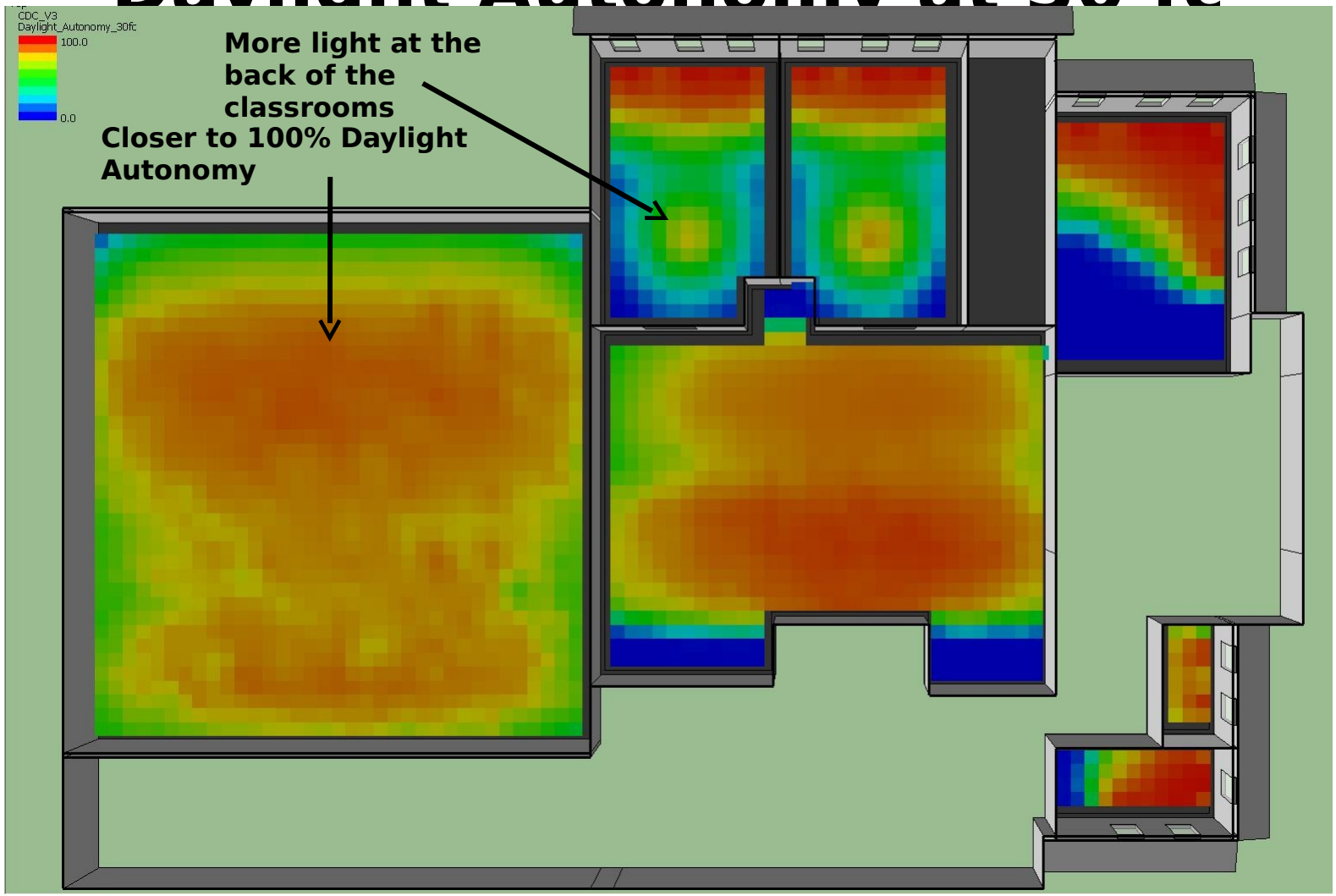
Hanging baffles



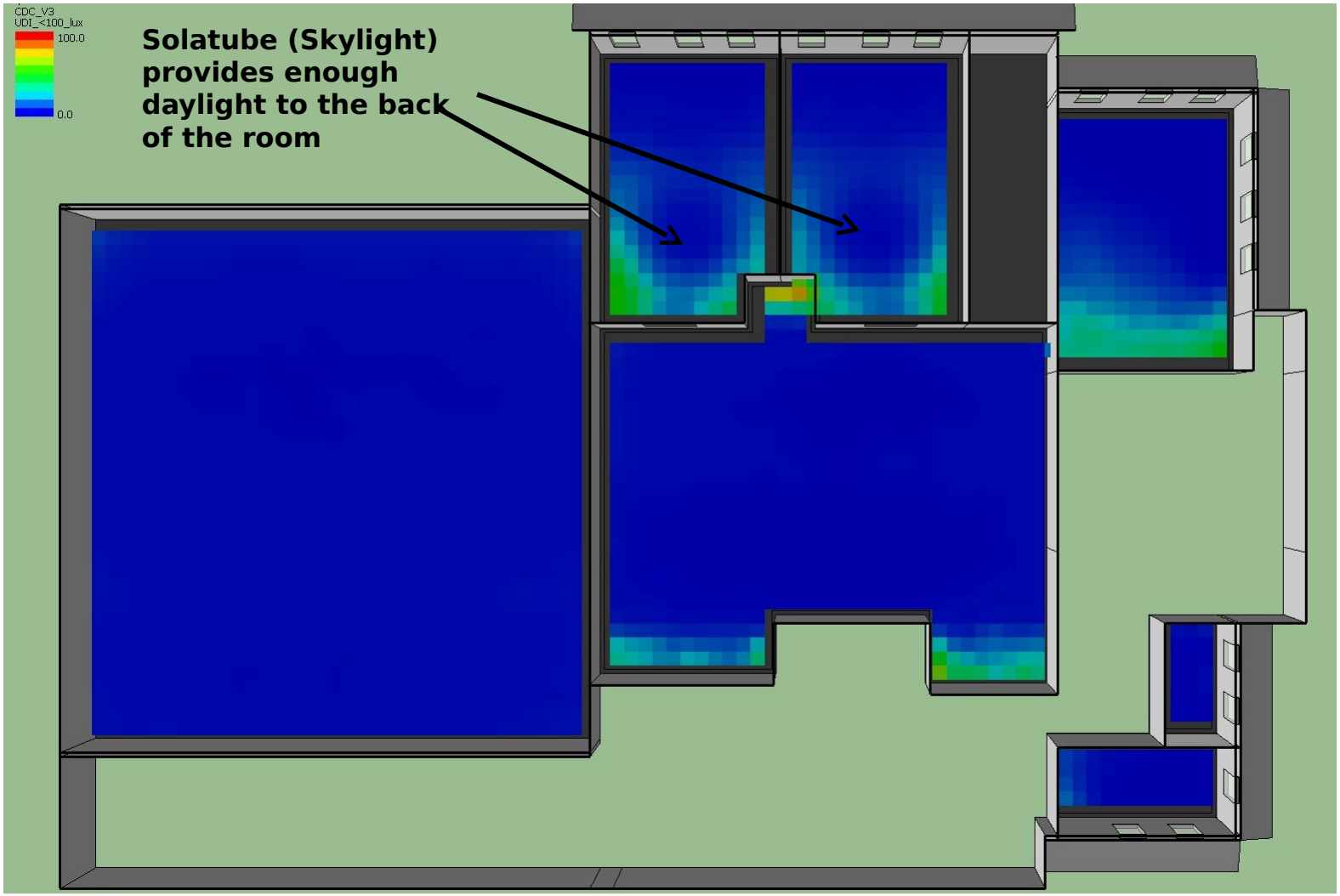
Summary

- The following measures have been incorporated in the new model and the daylighting results are satisfactory.
  - Sulatubes (skylights) in the two north-facing classrooms
  - Tinted (40% VLT) glass for all of the east-facing windows and the south-facing windows in the training room.
  - Translucent fabric baffles in the multipurpose room and the atrium.
  - Increased north-facing glazing area in the multipurpose room the and atrium.

Updated Model with Recommendations Daylight Autonomy at 30 fc

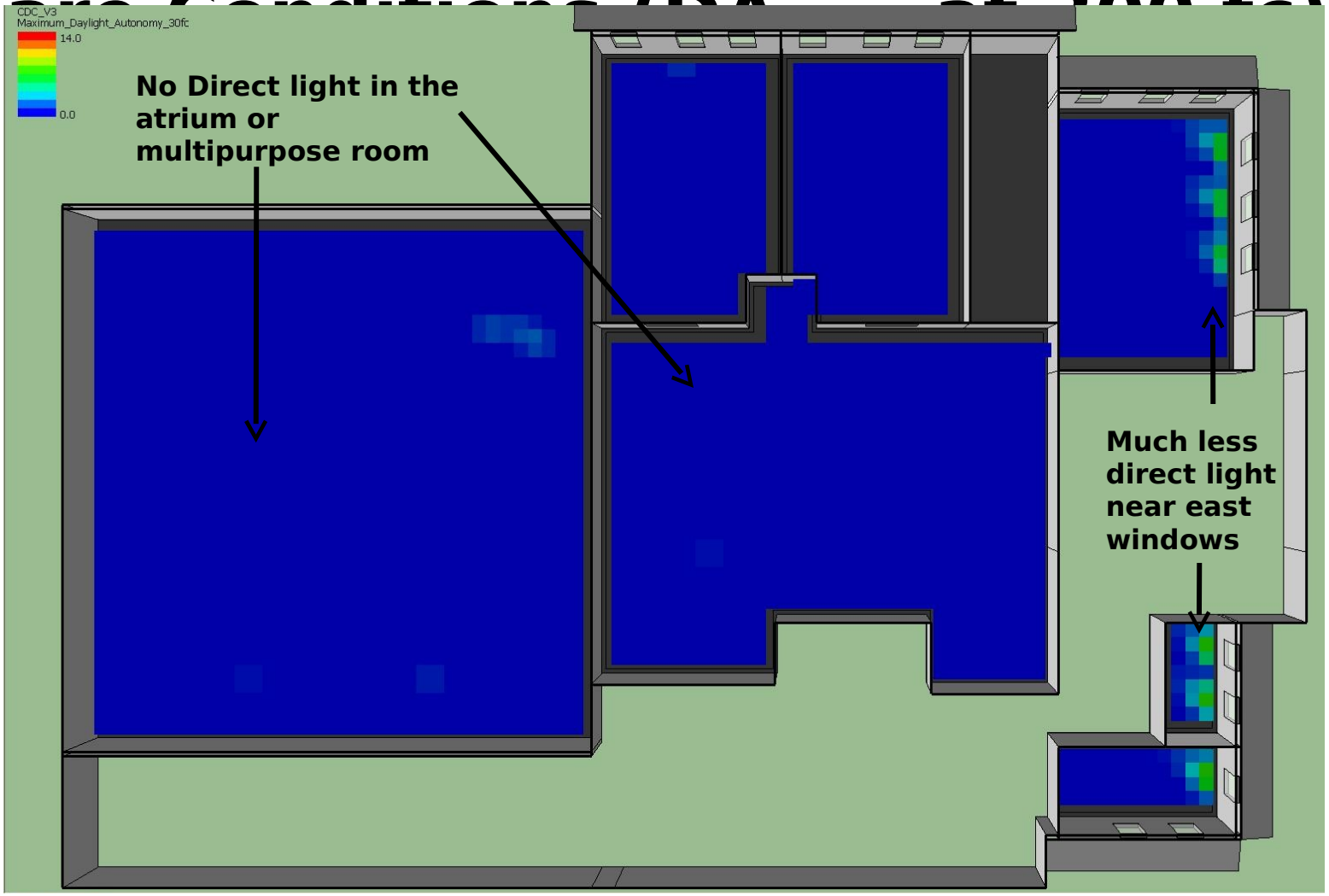


Updated Model with Recommendations Areas with less Daylight (UDI_{100})

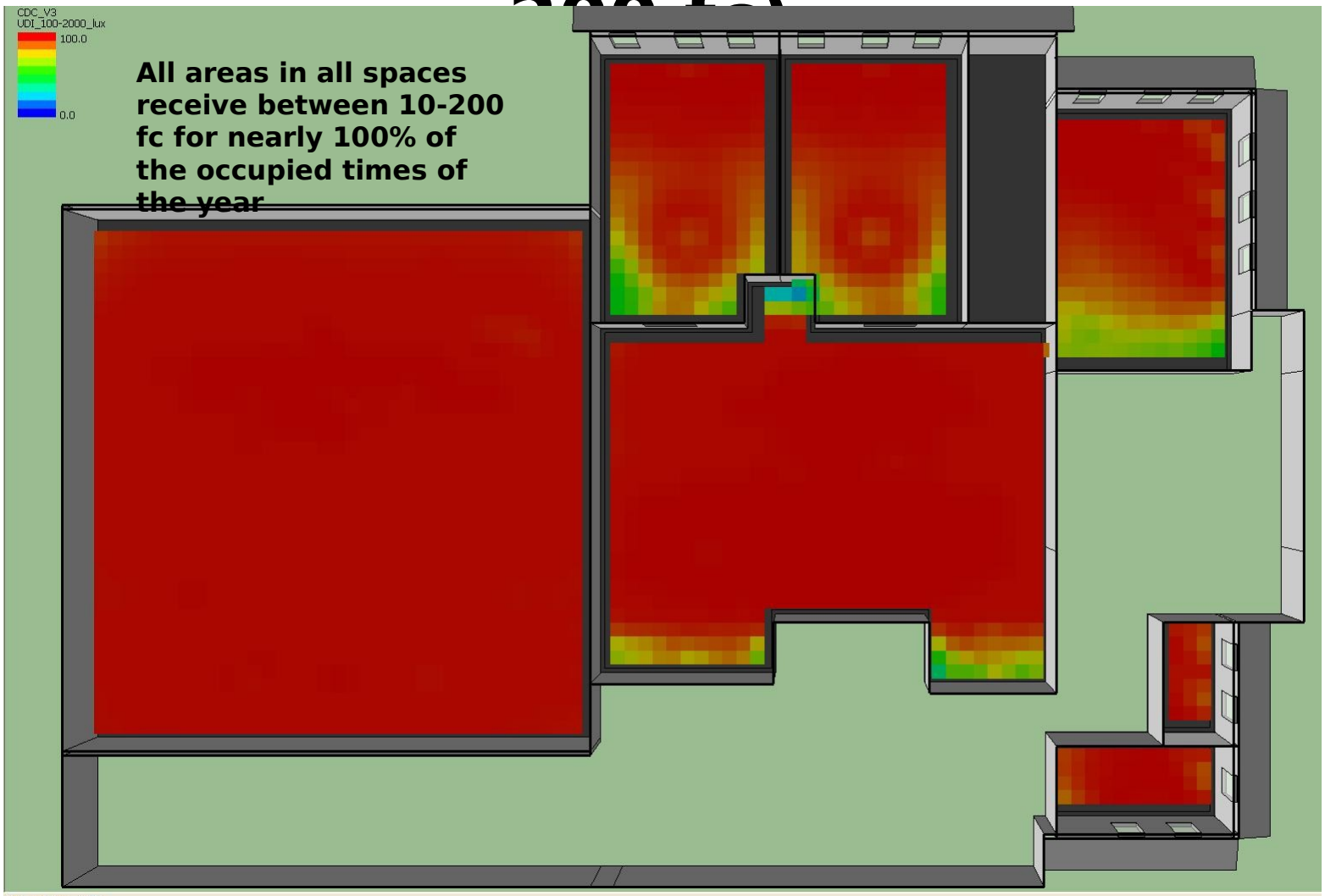


Updated Model with Recommendations

Gl



Updated Model with Recommendations
Useful Daylight Illuminances (10-200 fc)


CDC_V3
UDI_100-2000_lux
100.0
0.0
All areas in all spaces receive between 10-200 fc for nearly 100% of the occupied times of the year